Fabric, Inflated, Insulating Shroud for Cryogenic In-Space Transportation, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

The Cryogenic Encapsulating Launch Shroud and Insulated Upper Stage (CELSIUS) innovative layered system combines functions of Multi-Layer Insulation (MLI), Micro-Meteoroid and Orbital Debris (MMOD) protection, and fairing functions (exposure to free stream) into a deterministic soft-goods system that provides far greater performance for far less mass than the equivalent State of the Art (SOTA) systems performing the same functions. CELSIUS provides nearly perfect radiation dominated thermal performance. A 5 layer system MLI/MMOD system limits heat load to a cryogen to <0.5 W/m ^2 and gives >95% probability of no penetration for a two year mission in low Earth orbit and is readily scalable to other mission types. The system is applicable to large structures, including cryogenic tanks. Furthermore CELSIUS is robust enough to tolerate the vibrations, load, dynamic pressures, and heating of the launch ascent environment allowing it to protect nearly any portion of the launch stack up to and including serving as a complete launch fairing. Our Phase II effort matures the concept through analysis, design, subscale test and validation activities; including simulation of the highest risk areas of free-stream exposer and vibration at launch followed by system deployment while at cryogenic cold-soak. This effort significantly improves the TRL of the system and we exit Phase II with complete validation and having completed a Preliminary Design cycle in support of technology insertion onto the SLS EUS.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: CELSIUS has application to NASA as an insulation solution for the exposed Hydrogen tank barrel section on the SLS Exploration Upper Stage (EUS). CELSIUS can, for minimal mass provide ascent-to-orbit protection for the barrel section and excellent long term thermal and MMOD protection. CELSIUS will greatly extend the

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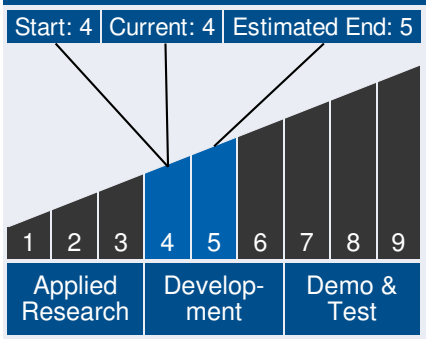
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

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EUS on-orbit life providing NASA improved mission flexibility for Exploration Missions. CELSIUS also has future application for orbital propellant depots, habitats, and as a complete launch fairing solution. In this role, CELSIUS may be an enabling technology that provides a single solution to the ground-to-orbit and long term on-orbit storage of cryogenic propellants. With CELSIUS there is never a moment when the cryogenic system is unprotected, nor is transfer needed. The CELSIUS fairing and insulation system is carried directly to orbit and remains to protect the cryogen system from the duration of its useful life. CELSIUS is being investigated for ground applications for improved cryogenic insulation. This is a particularly large cost for NASA, the United States Air Force, and commercial launch providers who must maintain facilities and produce or deliver cryogenic propellants in large quantities in some of the warmest and most humid regions of the country.

To the commercial space industry:

Potential Non-NASA Commercial Applications: CELSIUS has significant interest from commercial launch providers where it can improvements cryogenic upper stage thermal and MMOD protection for minimal mass. This enables on-orbit services and mission flexibility in GEO, and planetary missions. It will also allow commercial providers to contemplate on-orbit upper-stage refueling and depot concepts for far greater mission capability that currently available. CELSIUS, as a complete inflated launch shroud or booster nose-cone would save hundreds of kilograms vs traditional systems. CELSIUS is being investigated for ground applications for improved cryogenic insulation. This is a particularly large cost for NASA, the United States Air Force, and commercial launch providers who must maintain facilities and produce or deliver cryogenic propellants in large quantities in some of the warmest and most humid regions of the country.

Management Team *(cont.)*

Principal Investigator:

- Chad Bower

Technology Areas

Primary Technology Area:

In-Space Propulsion Technologies (TA 2)
└ Chemical Propulsion (TA 2.1)
  └ Liquid Cryogenic (TA 2.1.2)

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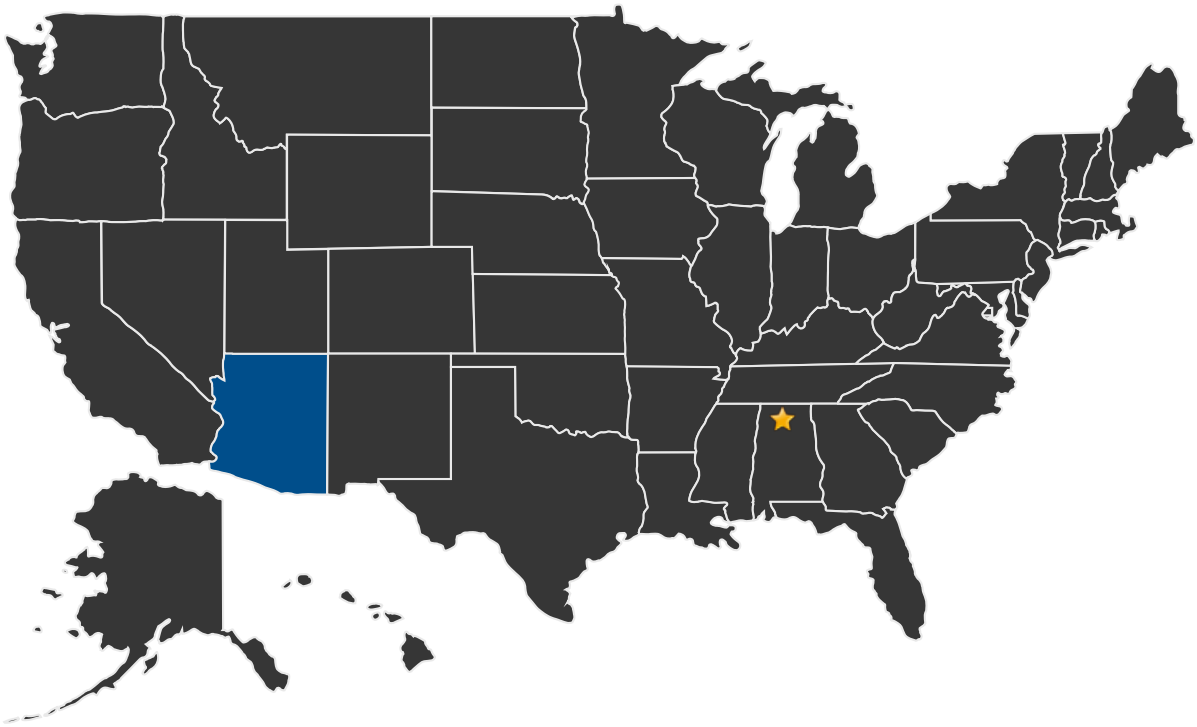
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Marshall Space Flight Center

Other Organizations Performing Work:

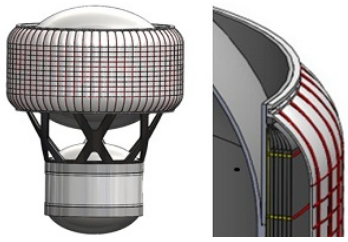
- Paragon Space Development Corporation (Tucson, AZ)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23602)

IMAGE GALLERY



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DETAILS FOR TECHNOLOGY 1

Technology Title

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